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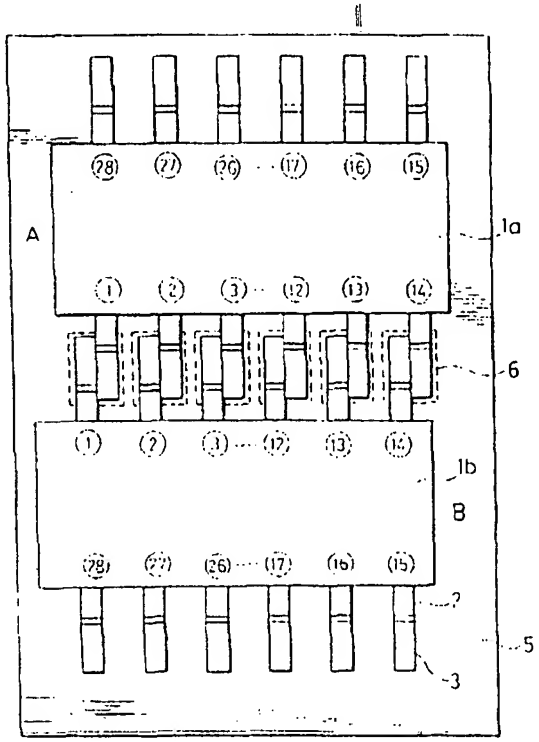
(54) **A semiconductor device comprising two integrated circuit packages.**

(57) A semiconductor device includes a package substrate (5), a first IC package (1a) having external lead terminals (2) which are downwardly bent with respect to a plane surface of the package and a second IC package (1b) having external lead terminals which are upwardly bent with respect to a plane surface of the package. These packages are provided on one surface of the package substrate and arranged in parallel with each other. One or more pairs of the external lead terminals of the first and second IC packages, which are facing to each other and to be electrically connected with each other, are arranged on the same mount pads (6) provided on the package substrate. Therefore, wires for connecting those lead terminals can be dispensed with and the other external lead terminals can be connected by simply drawing around wires without providing through holes. In addition, no positional deviation between the two packages occurs and no solder bridge of the leads owing to a complicated soldering occurs.

FIG 1



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FIELD OF THE INVENTION

The present invention relates to a semiconductor device which is formed by mounting semiconductor packages having integrated circuits on a package substrate.

BACKGROUND OF THE INVENTION

Figure 4(a) is a plan view showing an IC package having external lead terminals which are downwardly bent with respect to a plane surface of the package (hereinafter referred to as an A-type IC package). Figures 4(b) to 4(d) are a side elevational view, a front elevational view, and a sectional view, respectively, of the A-type IC package. Here, a small outline package (SOP) is employed. As shown in figure 4(d), an IC chip 7 disposed on a die pad 10 is electrically connected with external lead terminals 2 by bonding wires 11. The die pad 10, the IC chip 7, parts of the external lead terminals 2 and the bonding wires 11 are packaged by mold plastic to produce the A-type IC package 1a.

Figure 2 is a plan view showing a prior art semiconductor device, in which a pair of A-type IC packages are mounted on one side of a package substrate. In figure 2, the A-type packages 1a are mounted on the package substrate 5. Soldering portions 3 of the external lead terminals 2 are connected to the package substrate 5 by solder, and thus the A-type packages 1a are fixed onto the package substrate 5. The A-type packages 1a are connected with each other by wires 10 and through holes 8. The external lead terminals 2 have pin numbers of ① -- ㉘ , respectively.

Description is given of a method for mounting the A-type IC package 1a on the package substrate 5. Figure 3 is an enlarged sectional view of a lead connection part of the A-type IC package. First, solder 4 is previously applied to a mount pad 6 of each electrode portion formed on the surface of the package substrate 5. Then the package 1a is mounted on the package substrate 5 by that the soldering portion 3 of the external lead terminal 2 is soldered to the mount pad 6 by the solder 4 to be electrically and mechanically connected to the same.

In order to obtain a construction in which two A-type packages 1a are mounted on the substrate 5 and the external lead terminals 2 of the packages having the same numbers of pins are mutually connected with each other as shown in figure 2, it is necessary to provide wires 9 of complicated arrangements and also to provide through holes 8 penetrating the package substrate 5.

As described above, in this prior art semiconductor device, a pair of A-type packages are mounted on one surface of the package substrate and the external lead terminals of the packages having the same numbers of pins are connected with each other as shown in figure 2. Then, wires 9 inevitably intersect with each other and wires 9 of complicated arrangements are provided. Further, the through holes must be provided penetrating through the package substrate 5.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a semiconductor device in which external lead terminals of two packages, which are to be electrically connected with each other and which have the same numbers of pins arranged symmetrically with each other, are connected on the same mount pads with no intersection of wires and no necessity of providing through holes, in a single-surface mounting of IC packages.

Other objects and advantages of the present invention will become apparent from the detailed description given hereinafter; it should be understood, however, that the detailed description and specific embodiment are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

In accordance with an aspect of the present invention, a first IC package having external lead terminals which are downwardly bent with respect to a plane surface of the package and a second IC package having external lead terminals which are upwardly bent with respect to a plane surface of the package are mounted on one surface of a package substrate such that the external lead terminals of the two packages, which face to each other and are to be electrically connected with each other, are arranged on the same mount pads. Therefore, wires of complicated arrangements and through holes can be dispensed with. In addition, in a construction where the external lead terminals of the two packages are arranged such that the external lead terminals of either package are arranged between those of the other package, high density mounting can be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view showing a semiconductor device on which IC packages are mounted in accordance with an embodiment of the present invention;

Figure 2 is a plan view showing a semiconductor device on which IC packages are mounted in accordance with the prior art;

Figure 3 is an enlarged sectional view of a lead connection part of the IC package shown in figure 2;

Figures 4(a) to 4(d) are a plan view, a side elevational view, a front elevational view, and a sec-

tional view, respectively, of an A-type IC package; Figures 5(a) to 5(d) are a plan view, a side elevational view, a front elevational view, and a sectional view, respectively, of a B-type IC package; and

Figures 6(a) to 6(c) are diagrams showing a distinction between a mount pad and a wire.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention will be described in detail with reference to the drawings.

Figure 5(a) is a plan view showing an IC package having external lead terminals 2 which are upwardly bent with respect to a plane surface of the package (hereinafter referred to as a B-type package). Figures 5(b) to 5(d) are a side elevational view, a front elevational view, and a sectional view, respectively, of the B-type package. This B-type package is different from the aforementioned A-type package only in the manner of bending of the external lead terminals.

Figure 1 is a plan view showing a semiconductor device in accordance with an embodiment of the present invention. In figure 1, the A-type IC package 1a and the B-type IC package 1b are mounted on the package substrate 5. External lead terminals 2 of the respective packages 1a and 1b are designated by pin numbers ① to ㉘.

As described above, the A-type package 1a and the B-type package 1b are different from each other only in the manner of bending of the external lead terminals.

Therefore, when the A-type package 1a and the B-type package 1b are arranged in approximately parallel with each other on the substrate 5 as shown in figure 1, the lead terminals 2 of the A-type package 1a having pin numbers of ① to ㉘ are arranged in positions line symmetrical (in a relation of mirror image) with positions of the external lead terminals 2 of the B-type package 1b having the same pin numbers.

Description is given of the function and effect hereinafter.

In this embodiment, two kinds of packages, i.e., the A-type package 1a and the B-type package 1b, are mounted on the package substrate 5 unlike the conventional one.

In a case of single-surface mounting, the A-type and B-type packages 1a and 1b are mounted on one surface of the package substrate 5 as shown in figure 1. In this case, external lead terminals 2 of the package 1a are arranged in positions line symmetrical (in a relation of mirror image) with positions of the external lead terminals 2 of the package 1b having the same pin numbers. Therefore, the external lead terminals facing to each other, i.e., those of pin numbers ① to ⑭, can be arranged on the same mount pads 6, so that wires can be dispensed with. In addition, other external lead terminals, i.e., external lead terminals of pin numbers ⑮ to ㉘, can be electrically connected with those of the other package simply by drawing around wires without necessity of providing through holes.

In the above embodiment of figure 1, since the external lead terminals 2 of the B-type package 1b are arranged between those of the A-type package 1a, the soldering portions 3 of the external lead terminals 2 of respective packages 1a and 1b having the same pin numbers can be arranged on the same mount pads without drawing around wires. In addition to the above-described effects, the area of the substrate on which these packages are mounted can be reduced, resulting in high-density mounting.

Methods for mounting the soldering portions 3 of the external lead terminals 2 (hereinafter referred to simply as leads 3) on the mount pad 6 are illustrated in figures 6(a) to 6(c).

The mount pad 6 is fundamentally a conductor used for connection or installation of element parts. Now suppose that the width of the lead is ℓ and the width of the member connecting two leads (mount pad or wire) is L. In case of figure 6(a), if $2\ell \leq L$, it can be said that the two leads 3 are mounted on the same mount pad 6. In case of figure 6(b), if $\ell \leq L$, it can be said that the two leads 3 are mounted on the same mount pad 6. However, in case of figure 6(c), a portion 9 having a width of L' which is narrower than the width of the lead 3, that is $L' < \ell$, is provided between the two mount pad portions 6 for mounting the leads 3 and this portion 9 is recognized as a wire. However, wires are covered with insulating solder resist in many cases. Therefore, such a case where the mounting of two or more leads is conducted on an area on which mounting of element parts is possible is covered by the present invention as construed that connection of leads on the same mount pad is carried out.

As described above, in the above-described embodiment, the A-type package having external lead terminals downwardly bent and the B-type package having external lead terminals upwardly bent are mounted on the package substrate and the external lead terminals of both packages are located in positions line symmetrical with each other, so that the external lead terminals facing to each other can be electrically connected on the same mount pads. Therefore, there is no necessity of providing wires for connecting those lead terminals and the other external lead terminals can also be connected by simply drawing around wires without providing through holes. In addition, no positional deviation between the

two packages occurs and no solder bridge of the leads owing to a complicated soldering occurs.

While in the above embodiment small outline packages are described, the present invention can also be applied to a plastic leaded chip carrier (PLCC) having external lead terminals formed into J-shape or a J lead type small outline package having J-shaped leads. Thus, the present invention is applicable to all surface-mounting type packages.

While in the above embodiment pin numbers are allotted to the external lead terminals and the lead terminals having the same pin numbers are connected with each other, the pin numbers are not always necessary to be allotted if two lead terminals to be electrically connected are certainly connected with each other. In addition, all of the lead terminals are not necessary to be connected. However, at least a pair of lead terminals should be connected.

While in the above embodiment the external lead terminals are connected between two IC packages, one or more pairs of external lead terminals of the same IC package, which are adjacent to each other, can be connected on the same mount pads 6 by that they are mounted in such a manner as shown in figure 6(a).

As is evident from the foregoing description, according to the present invention, a first IC package having external lead terminals which are downwardly bent with respect to a plane surface of the package and a second IC package having external lead terminals which are upwardly bent with respect to a plane surface of the package are mounted on a package substrate such that external lead terminals of the two packages having the same pin numbers are arranged in positions line symmetrical with each other, and the external lead terminals facing to each other are connected on the same mount pads. Therefore, the amount of wires to be provided on the substrate can be largely reduced. In addition, external lead terminals other than those which are mutually connected with each other as described above can also be electrically connected by simply drawing around wires, without occurring intersections of wires and without providing through holes.

Claims

1. A semiconductor device comprising:
   a package substrate;
   a first IC package having external lead terminals which are downwardly bent with respect to a plane surface of the package and a second IC package having external lead terminals which are upwardly bent with respect to a plane surface of the package, which are provided on one surface of said package substrate and arranged in parallel with each other;
   one or more pairs of said external lead terminals of said first and second IC packages, which face to each other and are to be electrically connected with each other, being arranged on the same mount pads provided on said package substrate.

2. A semiconductor device in accordance with claim 1 wherein said external lead terminals of said first and second packages which are to be electrically connected with each other on the same mount pads are arranged such that the external lead terminals of either package are located between the external terminals of the other package.

3. A semiconductor device comprising:
   a package substrate;
   an IC package having external lead terminals and mounted on said package substrate;
   one or more pairs of said external lead terminals adjacent to each other being arranged on the same mount pads provided on said package-substrate.

4. A semiconductor device comprising:
   a package substrate; and
   first and second IC packages mounted on the surface of said package substrate, of which the external lead terminals along facing side edges thereof are arranged to be adjacent and are connected in one or more pairs.

FIG. 1

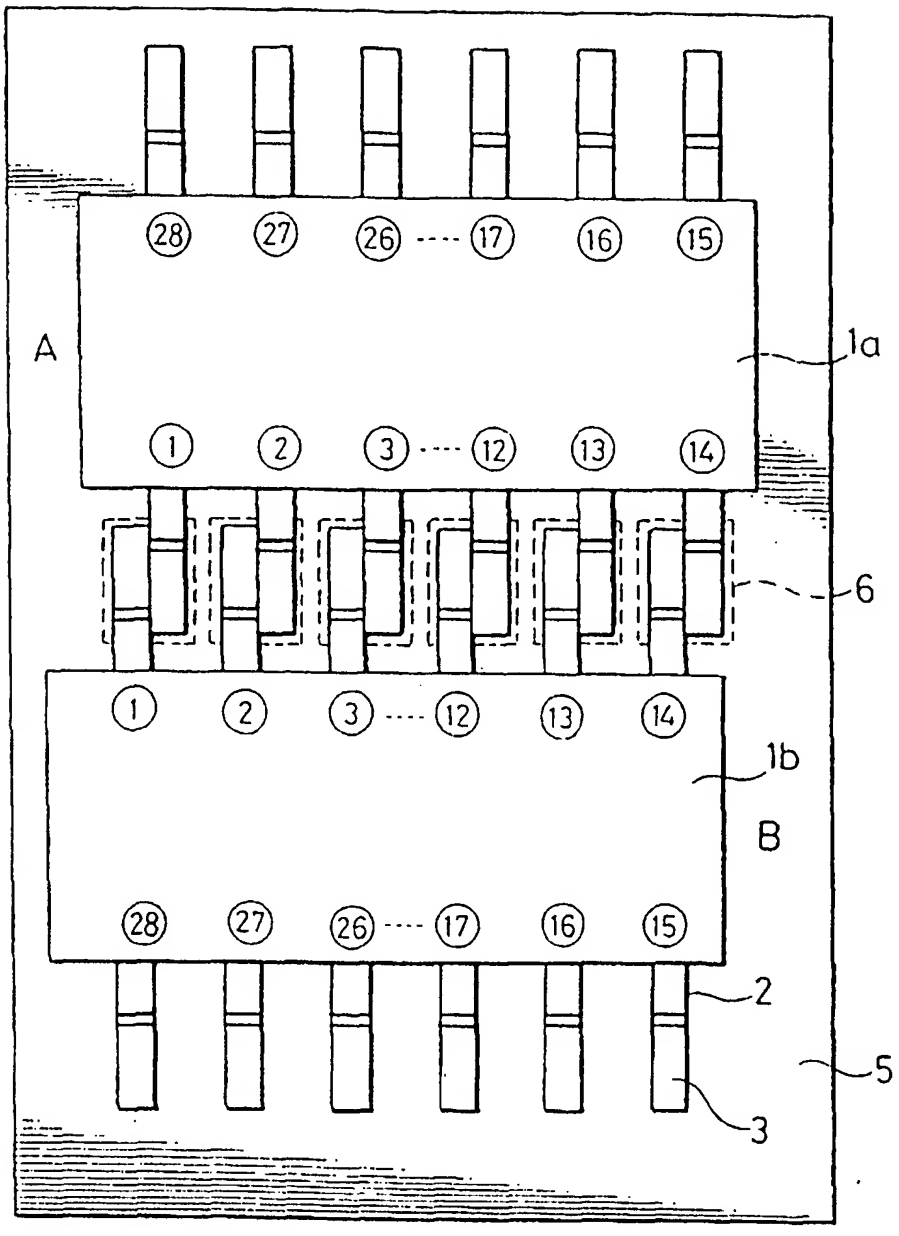


FIG. 2 (PRIOR ART)

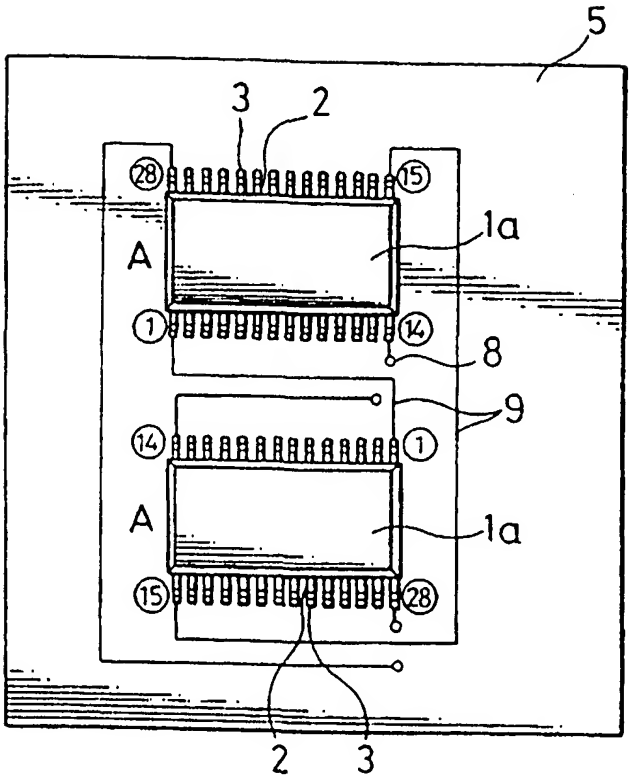


FIG. 3

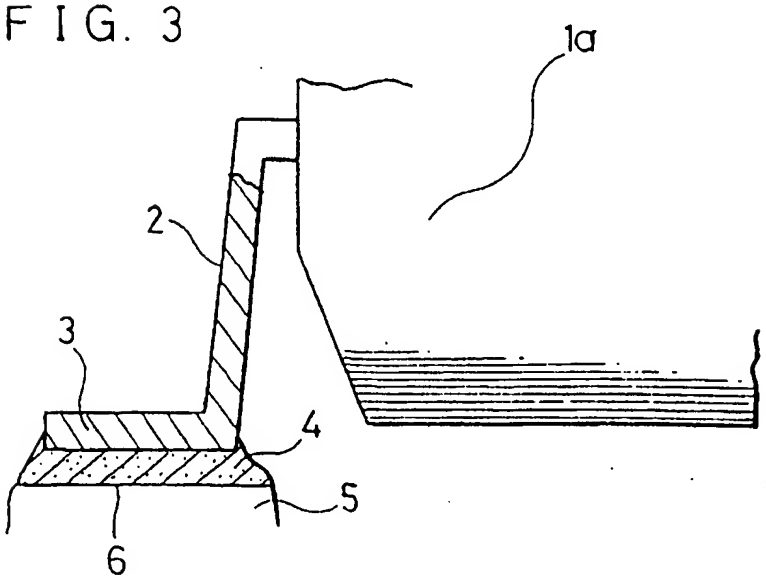


FIG. 4

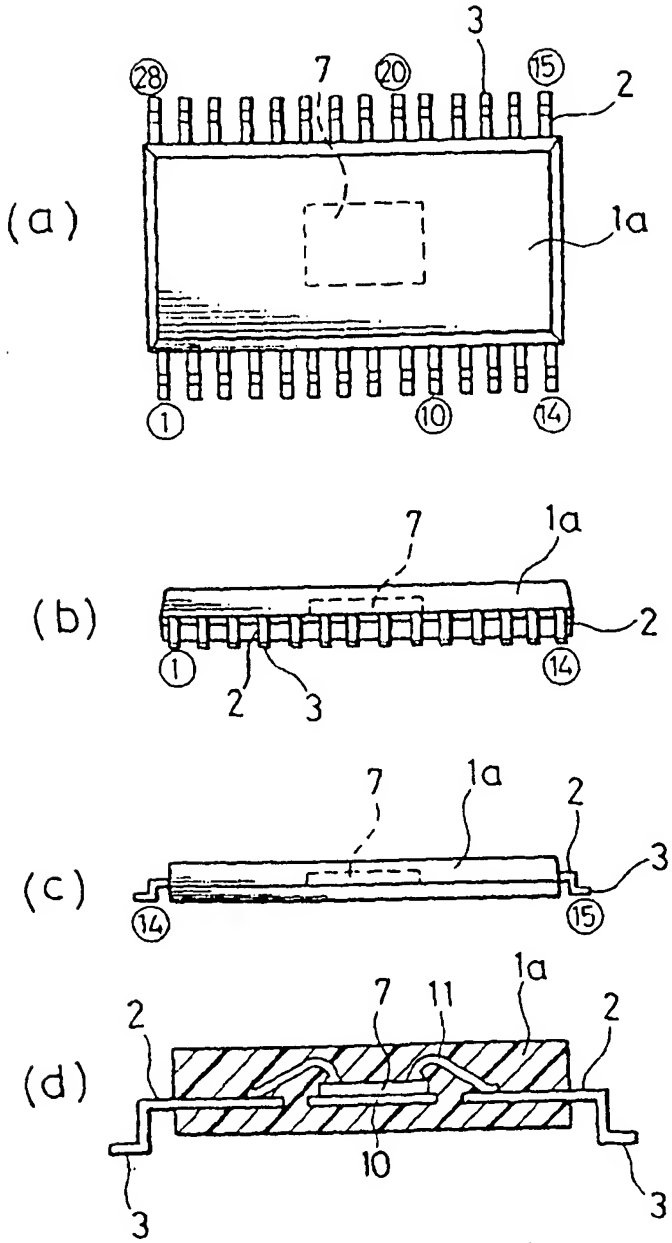


FIG. 5

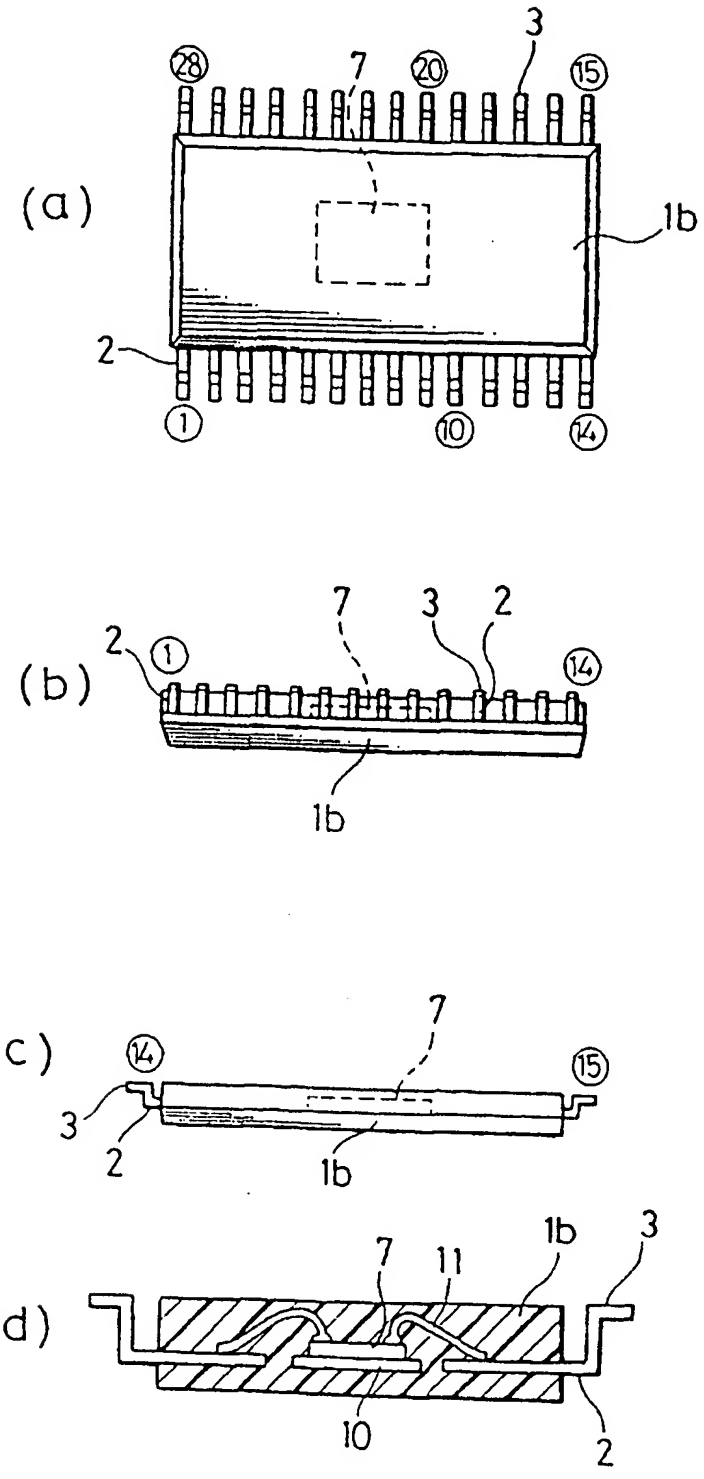
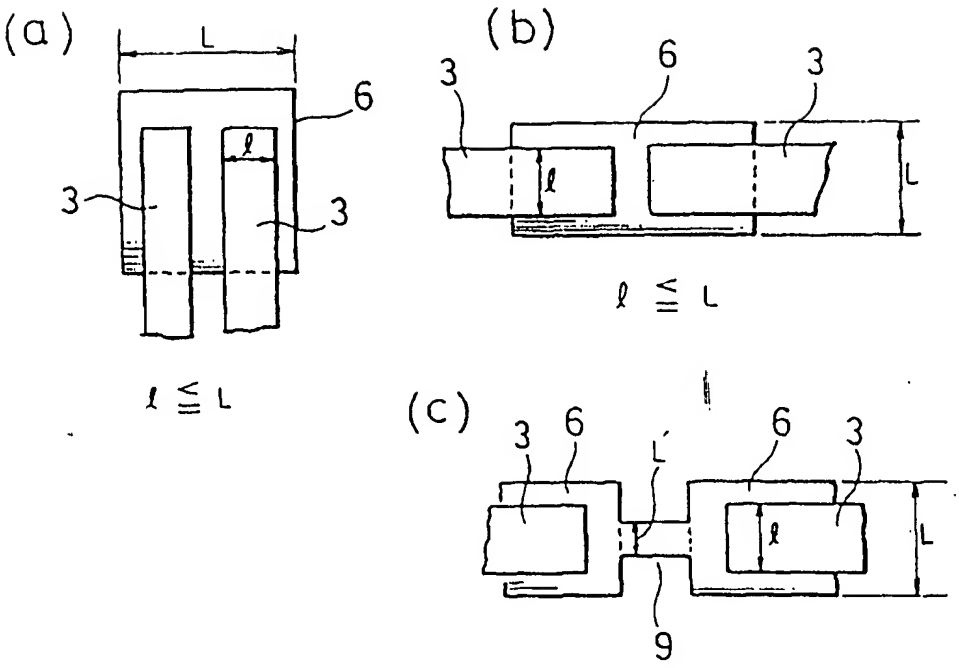


FIG. 6



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EUROPEAN SEARCH REPORT

Application Number

EP 91 30 9879

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	GB-A-2 145 561 (SHARP) * claim 1; figures 2,5-7 *	1	H01L25/10 H01L23/495
A	PATENT ABSTRACTS OF JAPAN vol. 11, no. 92 (E-491)(2539) 24 March 1987 & JP-A-61 244 054 (ZEROZU K.K.) 30 October 1986 * abstract *	1,4	
A	PATENT ABSTRACTS OF JAPAN vol. 10, no. 46 (E-383)(2103) 22 February 1986 & JP-A-60 200 559 (HITACHI SEISAKUSHO K.K.) 11 October 1985 * abstract *	1	
P,X	US-A-4 994 896 (MITSUBISHI)	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 FEBRUARY 1992	DE RAEVE R.A.L.

CATEGORY OF CITED DOCUMENTS

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